LUBRICATION

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Correspondence is invited. Address all communications to Dr. Canfield.

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EDITORIALS

We have received the following letter in regard to the article which appeared in last month's issue of "Lubrication" on "Steam Engine Lubrication":

NEW YORK, Jan. 3, 1918

Dr. L. H. CANFIELD,
The Texas Company,
17 Battery Place, New York City.

DEAR MR. CANFIELD: I have read over with interest the article on "Steam Engine Lubrication" in the December issue of "Lubrication" and it appears to have covered the field very thoroughly.

I would like, however, to criticise or rather amplify that part of the article in regard to crank case splash oiling systems. While it is true that there are no pipes or pumps to get out of order and that the bearings are always washed in oil, it is also self evident that the oil in a very short time becomes saturated with small particles of metal in addition to the water which comes over from the piston rod, thus making it entirely unsuitable for placing between the rubbing surfaces, without filtering it periodically.

In most modern plants where splash oiling engines are used, you will find a small hand type of oil filter, and the engineers remove the entire charge of oil from the crank case every week, or oftener if necessary, depending upon the service of that particular engine, and thoroughly purify this oil in the filter.

It has also been found advantageous in a number of cases to attach a pump and small combination filter-reservoir, placing the latter on the frame, so as to continually purify the oil. This, of course, does away with the necessity of the hand filter.—Yours very truly, EDWIN M. MAY.

To those interested in Lubrication, descriptions of filtering systems are always of value, and it is with pleasure that we reprint in this issue Lieut. Commander Church's article on "Forced Lubrication," in which he describes the filtering systems used on the battleships of the United States Navy.

THRIFT, THE INDISPENSABLE PREREQUISITE OF VICTORY

NEARLY everyone will remember the ancient fable of King Midas to whom it was vouchsafed that whatever he touched should turn to gold. Whereupon the venerable and greedy monarch approached the brink of the grave from starvation and was only saved at the last moment when the gods withdrew his magic gift.

But a great many people still believe that gold, or money, can feed and clothe armies and navies, though King Midas couldn't live by it; can produce ships and shells and guns by some process of alchemy which they don't pretend to explain.

The fact is, of course, that money (and the same holds true of bonds, even Liberty bonds) produces no more than do poker chips or brass checks or any other convenient tally. It is equally as edible; it kindles no better fire; it can be shot from French 75s with about the same effect. Civilization has simply confused our minds with its complications. But if we go back to first principles the case becomes clear.

The things which are productive, which do count, whether in the support of King Midas or Uncle Sam, are goods and services, things to eat and wear and shoot and the human labor which produces and consumes them. Only, the labor must produce more than it consumes, since it is on this surplus alone that the army and navy and all related services, whether at home or in France, subsist and function. Every loaf of bread and bag of coal which our present economy provides is grist to their mills; every servant we can give who might be employed in a munition plant or on the farm—and this applies to bootblacks and delivery boys and the many others who pander to the laziness of all of us, as well as to butlers and ladies' maids and chauffeurs; and every minute of our own labor which we could make more productive strengthens the nation's fighting machine.

"The gospel of goods and services is the gospel which, in season and out of season, the National War Savings Committee has been preaching throughout Great Britain for the last eighteen months. The war can be paid for only out of savings."

These are the words of Basil P. Blackett, of the British Treasury, in an address before American bankers last September. On this same occasion he also said:

"These resources cannot be increased by any juggling of finance. It does not matter to the gunner whether the shell which he is firing cost half as much or twice as much as it would have cost in 1913. What matters is that he should have the shell."

FORCED LUBRICATION

By Lieutenant Commander A. T. Church, U. S. N., Member.*

THE following is a compilation of forced-lubrication data for the most part from reports of officers in the Fleet.

Oil is supplied under pressure to main bearings, crank-pin bearings, crosshead pins, crosshead guides, eccentrics, and ahead faces of thrust-bearing horseshoes. At each main bearing a radial hole is drilled through the wall of the crank shaft to the axial hole in the shaft. In the path of this hole an annular recess is cut in the bearing brass. In a similar manner radial holes are drilled through the shaft and each eccentric to the axial-shaft hole. The axial hole in the crank shaft is connected to the axial hole in the crank pin by drilling a hole in the crank web. Radial holes are drilled in each crank pin to the axial hole in the pin. The axial hole in the connecting rod is extended through the crank-pin brass to the crank pin. The result of all these holes is to form a closed circuit for the oil from the main bearing supply pipe to the top of the connecting-rod axial hole. Oiltight caps are fitted at the ends of axial holes in the crank shaft and crank pins. A gage and thermometer is fitted at each bearing.

In the engine and pump room are located a forced-lubrication service pump, a service and return pump and a return pump; a supply oil tank and a water and oil-settling tank; three strainers for supply oil tank; two strainers for discharge to engines, one suction-well strainer box and one drain pump. The supply oil tanks are cross connected. Oil is supplied to the bearings by either the service pump or the service and return pump, the oil passing through strainers, either pump being capable of using either strainer and its own discharge line. At each bearing two valves are fitted, one for each oil-feed line, for the purpose of regulating the flow of oil.

The course of oil through the system is as follows: The service or the service and return pump draws the oil from the main supply tank through the suction-well strainer box and discharges through strainers to engine supply pipes. From the main supply pipe branch pipes conduct the oil to the main bearings through holes in the bearing caps. The quantity of oil supplied is regulated by valves at the bearings. Annular grooves distribute the oil through the main bearings and into the crank-shaft axial hole through the radial holes in the journal. The crank pins are lubricated through the hole in the crank web connecting the axial holes in the shaft and web and the radial hole in the crank pin. The eccentrics are lubricated through the radial holes drilled in the shaft and in each eccentric. The crosshead pins are supplied through pipes leading from the connecting rod through the crosshead pin and out through radial holes.

The thrust bearings are supplied by pipes from the main supply line. Valves are fitted at each thrust to regulate the supply. After performing its function, the oil is forced out at the ends of the bearings and drains to the crank pit, which serves the purpose of a trough for catching the oil. From the crank-pit oil well

* Reprinted by permission from the *Journal of the American Society of Naval Engineers*, August, 1917, p. 443.

the oil is drawn by the return pump and delivered through strainers to the main supply tank, thus completing the cycle.

The settling tanks provide a means for allowing impurities to settle, after which the cleansed oil can be returned to the system.

The illustration shows a diagrammatic arrangement of the forced lubrication for the turbines of a battleship. The oil pumps take their suction from the drain tank and discharge through a quadruple-flow cooler and thence to the different bearings, from which the oil drains by gravity to the drain tank. Strainers are fitted in the pump suctions. The discharge of oil from each turbine bearing is through a sight-feed glass, so that the flow of oil can be observed. A thermometer is fitted in each discharge. A valve for independent regulation of the flow is placed at each bearing. There is a complete system for the bearings on the port side of the ship and a system similar in all respects for the starboard side, the two systems being cross connected, so that in case of emergency the system on either side will provide lubrication to all bearings on both sides.

Where reduction gearing is fitted oil is led from the main supply pipe to a series of nozzles in the gear case. The nozzles are arranged to spray the oil at the point of mesh in both the ahead and backing directions.

The oil drains from the bottom of the main bearings and thrust bearings to the return oil pipe and thence to the drain pipe.

Operation.

On reciprocating-engine ships start the pumps from ten minutes to half an hour before getting under way. After starting the pumps they may be run for five minutes to insure that all bearings are getting a plentiful supply of oil and to fill the system so that the working pressures will be attained rapidly when pumps are started, then secure them and start again at the first bell for getting under way. Stop the pumps as soon as word is received from the bridge to secure the main engines, if they have run sufficient time after the last bell for all bearings to receive fresh oil.

On turbine ships oil pumps should be started from two to three hours before getting under way and run after engines are secured as long as the main circulating pumps are kept running. This is usually from two to three hours, although the Florida runs them from six to eight hours.

Pressures.

Pressures used by different vessels are as follows:

U. S. S. Texas (Reciprocating Engines): On the main engines the pressure usually carried at the pump is 20 pounds. Running at full power this pressure is increased to 30 pounds.

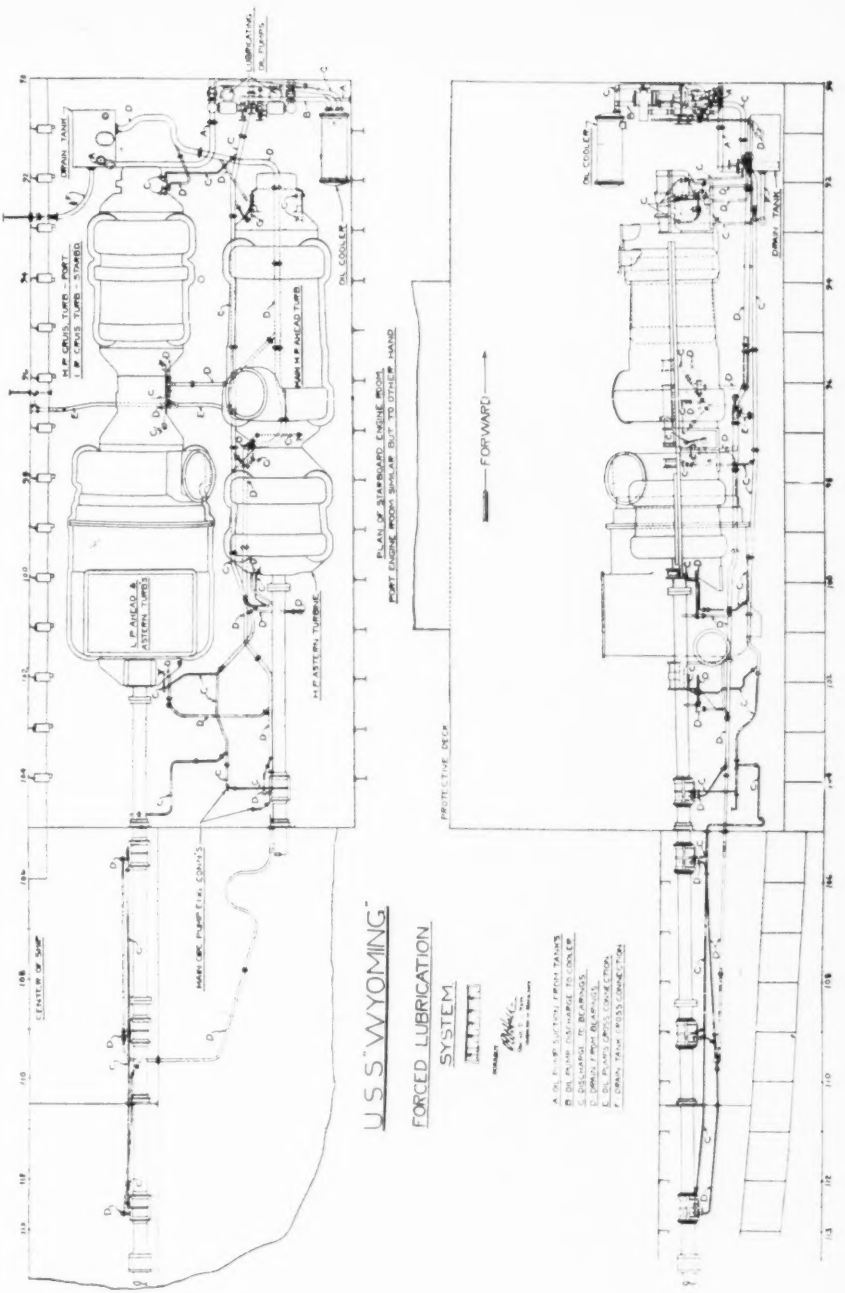
U. S. S. New York (Reciprocating Engines): Pressures carried on discharge side of strainers are from 20 to 30 pounds gage.

U. S. S. New Hampshire (Reciprocating Engines): Between 10 and 20 pounds by the oil-pressure gages on the various parts of the system.

U. S. S. Delaware (Reciprocating Engines): Fifteen to 35 pounds, depending upon viscosity of oil and speed of main engines.

U. S. S. Michigan (Reciprocating Engines): An oil pressure of 10 to 25 pounds is carried, depending upon the speed of the engines.

U. S. S. Florida (Parsons Turbines): The pressures carried on Parsons four-shaft turbines are 50


U.S.S. "WYOMING"
FORCED LUBRICATION SYSTEM
PLAN OF STARBOARD ENGINE ROOM
PORT ENGINE ROOM SIMILAR BUT TO OTHER HAND
FORWARD
PROTECTIVE DECK
MAIN H.P. AHEAD TURB.
H.P. ASTERN TURBINE
L.P. AHEAD & ASTERN TURBS.
M.P. CRUIS. TURB. - PORT
L.P. CRUIS. TURB. - STARBD.
OIL COOLER
DRAIN TANK
LUBRICATING OIL PUMPS
MAIN CIRC. PUMP ELEC. COMPS.
CENTER OF SHAFT
A OIL PUMP SUCTION FROM TANKS
B OIL PUMP DISCHARGE TO COOLER
C DISCHARGE TO BEARINGS
D DRAIN FROM BEARINGS
E DRAIN TANK SUCTION
F DRAIN TANK CROSS CONNECTION

pounds at pump and 10 to 12 pounds on farthest bearings.

U. S. S. Arkansas (Parsons Turbines): For cruising speeds the starboard oil-pump discharge pressure i 50 pounds gage, the port 65 pounds gage. This gives an average oil pressure at the bearing of about 5 pounds gage on each engine.

U. S. S. Utah (Parsons Turbines): Pressure at pump before passing through cooler, 25 pounds; pressure in system after leaving cooler, 12 pounds; average pressure on bearings, 9 pounds.

U. S. S. Wyoming (Parsons Turbines): Pressure carried at farthest bearings for 10 knots and above, 10 pounds; for below 10 knots, 9 pounds.

Leaks.

There are two classes of leaks: (a) oil, (b) water. Either class may be detected by the daily record of the quantity of oil in the drain tanks. If this tends to decrease abnormally it indicates an oil leak in the system, which is easily detected by inspection of bearings and piping. If, on the other hand, the drain tank gains oil it is an indication that there is a leak in the oil coolers permitting the circulating water to flow into the oil. The leak itself is detected by a pressure test of the cooler. No difficulty should be encountered from leaks when reasonable oil pressures are carried.

Oil leaks in coolers may be detected by means of a small pipe tapped into the highest point of the salt-water side of cooler. This pipe serves as a means of getting rid of air, and will show oil if any is leaking from the oil to the water side through the tubes or ferrules of the cooler.

If the oil gages show a sudden drop in pressure and the supply pump speeds up, inspection should be made to find the cause, which is usually the flooding of some part by opening the feeder valve too wide. If the pressure gradually drops and the supply pump speeds up accordingly, the trouble is usually due to wear of grasshopper joints to crosshead bearings or in main bearings, and should be remedied in port.

If the baffles at the ends of bearings are injured, oil is thrown out as the shaft revolves, and may be thrown out if oil pressure on the bearing is too high.

A ready means of remedying leaks in engine casings is by filling cracks with litharge and glycerine.

Under Way.

A careful watch should be kept on the pumps to see that they do not lose their suction and to keep the pressure constant. A careful watch should be kept on the temperature of the main bearings and thrust bearings, and the system should be frequently examined for the purpose of detecting leaks and to see that the oil is running freely.

Oil strainers should be cleaned every watch.

Effort should be made to keep the temperature of oil leaving the coolers not less than 90 degrees nor more than 110 degrees.

A record of average bearing temperatures under various conditions of speed, temperature of circulating water, etc., is of considerable value in determining whether or not temperatures are normal under varying conditions.

Tanks, Drain Pockets.

Where accessible, the drain pockets under main bearings should be frequently opened, drained and cleaned, as a very heavy sludge is apt to collect there.

Frequent inspection and care of the strainers in the system will aid

in keeping the tanks in good condition.

Tanks should be inspected as a matter of monthly routine. When tanks are inspected oil should be pumped to a treating tank, when available, and the oil treated by raising the temperature high enough to precipitate all water and sediment. The tanks themselves should be boiled out and swabbed.

It is not necessary to allow the oil to cool after heating before drawing off the water. The settling out is practically all done while the mixture is hot, and waiting for it to cool has little or no effect.

Oils.

Conditions in forced-lubrication systems are quite different from those in sight or wick-feed systems. Since the oil is used over and over again, any that may be squeezed out from between the bearing surfaces does not represent a loss; also the oil can be supplied in any amount, thereby eliminating the possibility of an insufficient supply to the bearings. Therefore a lighter oil may be used than with the wick-feed.

Every effort should be made to exclude water, since the oil must be kept in continuous circulation, and the effect of a water leak soon becomes cumulative. One of the primary requisites of a forced-feed oil is that it must not saponify and must separate readily from water. Too much care cannot be exercised to keep the oil clean and free from the least grit that excessive wear of bearings may be avoided.

Tests.

Heat sample up to 400 degrees F.; on cooling, oil should not be much darker than it was before heating.

Fill a bottle one-quarter full of oil and then add twice as much boiling water as there is oil, shake well, and allow mixture to stand or settle. There should be no deposit, and the line of separation between the oil and water should show practically no paraffine or solid matter. The oil and water should separate wholly, and there should be no emulsification or saponification.

Fill a test tube with oil and strained gasoline. Shake well and allow to stand for a few minutes. The gasoline, oil and any water that may be in the original oil will form three distinct layers, and the test gives an indication as to whether or not the oil requires heat treatment for elimination of water.

The Bureau of Steam Engineering requires that forced-lubrication oil for main engines must be a pure mineral oil with sufficient body, must not form an objectionable emulsion when steam is bubbled through it; and when stirred vigorously for five minutes with cold or boiling distilled water or salt water, must settle out promptly, leaving as a deposit only a small percentage of separated matter.

Suitable oils for forced-feed lubrication are Texaco Ursa (heavy oil; 750 viscosity at 100 degrees F.); Texaco Algol (heavy oil; 500 viscosity at 100 degrees F.); Texaco Alcaid (medium oil; 300 viscosity at 100 degrees F.); D. T. E. heavy (medium oil; 300 viscosity at 100 degrees F.); Texaco Cetus (light oil; 200 viscosity at 100 degrees F.).

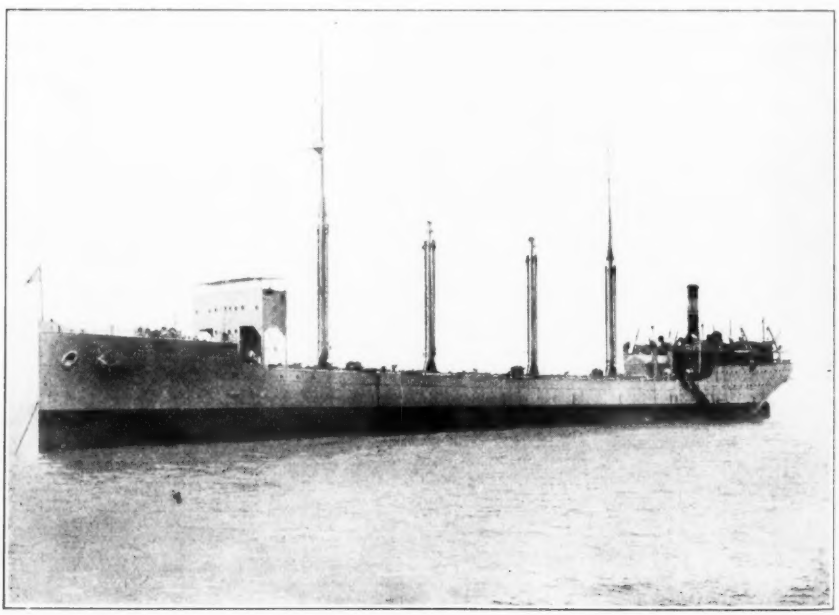
Engineer officers should acquaint themselves with the Bureau of Supplies and Accounts' memorandum, which shows oils suitable for different purposes, so that the wrong oil will not be used when a special kind of oil is necessary. In some cases a very high-priced oil has been used when a much cheaper oil would answer satisfactorily, and in other cases com-

plaints have been received when a low-priced oil has been used for the wrong purpose. The lubricating value is dependent upon the quality of the oils, and a mixture of different oils gives a result closely approximating the average lubricating value of the oils mixed. In forced-lubrication systems it is permissible to add oil of a different brand to make up losses, and oils may be changed without it being necessary to take all of the old oil out of the system before the new brand can be used.

DIESEL ENGINE LUBRICATION ON U. S. S. MAUMEE

IN the issue of December, 1916, we called attention to a demonstration of the operation of the Diesel engines of the fuel oil ship U. S. S. Maumee, which was given on November 6, 1916, at the Brooklyn Navy Yard. This demonstration was made just before the ship was put into commission in order to give a practical exhibition of the performance of the highest powered marine Diesel engines installed on any vessel. The following quotation is made from the article referred to:

"The original designs for the Maumee's engines were secured from Machinen Fabrik Augsberg-Nurnberg, Germany, through the New London Shipbuilding and Engine Co., New London, Conn. The engines were built by the Machinery Division, Navy Yard, New York, under the immediate supervision of Lieutenant C. W.



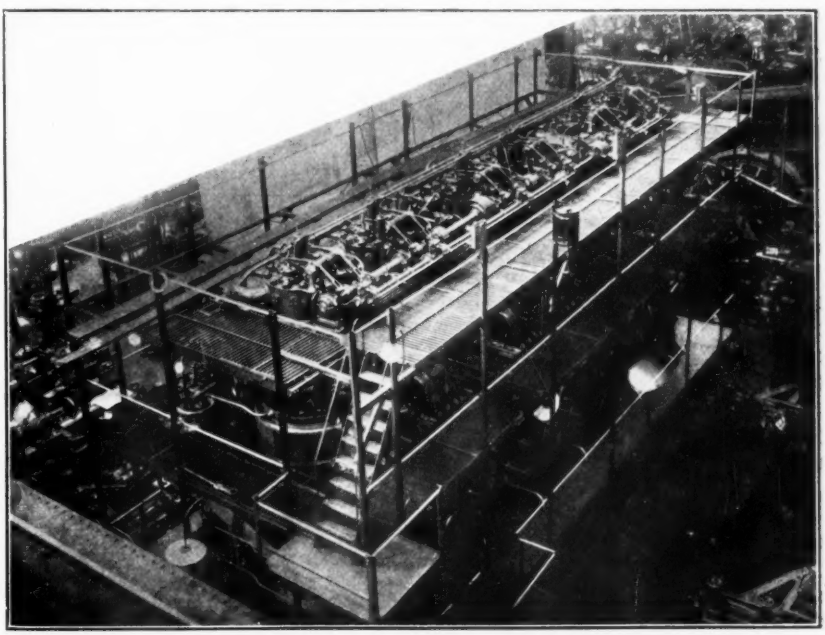
U. S. S. Maumee

Nimitz, of the U. S. Navy. They are six-cylinder, two-cycle single acting Diesel engines of 2,600 S. H. P. (shaft horse power) each; the diameter of each cylinder is 25.2″, the stroke 37.37″, and the revolutions per minute 130. At the demonstration each engine indicated 3,170 h. p., about twenty per cent. above their rated h. p.

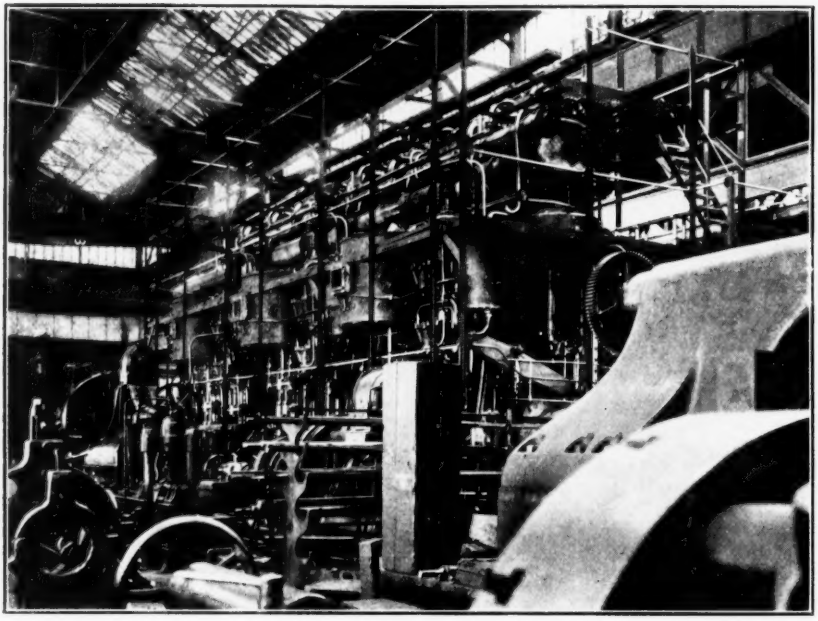
"They were first erected on heavy concrete foundations in the shop, and direct connected to large dynamos, loaded down by means of a wet resistance to get the desired load, and then run for several weeks so as to develop any defects that might exist. They were then dismantled and re-erected in the ship, given a severe series of dock trials, after which the ship went to sea for her sea trials. The bed plates are 43 feet long and 14 feet wide, and it is 25 feet from the bed plate to the top of the cylinders.

"In the Navy, when there is so much at stake, naval engineers are very particular as to what lubricants they will use. The fact that from the very first the only oil that was considered and that has been used on the entire engine installation for this ship was TEXACO Ursa Oil speaks wonders for its action as a high grade Diesel Engine lubricant.

"It required 50 barrels of Ursa Oil to fill the main oiling system, which supplied the twelve combustion cylinders, the six three-stage air compressors, the auxiliary air compressor, the two main thrust bearings, and all the crank pins, main shaft and other bearings of these two great engines. During the various



View of Maumee's Engines from Above



Side View of Maumee's Engines

trials there has not been a minute's delay or trouble attributable to the oil. Tests of this kind prove the claim that TEXACO Ursa Oil is the finest Diesel engine lubricant ever made."

During the first few months that the Maumee was in service she covered an average of nearly 4,000 miles per month without a hitch. The engines proved very satisfactory in service and have been ready to respond in any emergency. The only defect that developed was the cracking of some of the cylinder jackets, which was apparently due to lack of sufficient clearance between the working liners and jackets.

According to a recent article in *Marine Engineering*,* the fuel economy of the engines is excellent, the consumption being less than one-half that required for the most economical steam plants. Specification Navy Fuel Oil is used, and the consumption is about five-tenths pound of oil per shaft horse power. The engines are easily handled, and as the Maumee is constantly required to go alongside of vessels, tugs, etc., the handling requirements are particularly severe. The overhaul and upkeep requirements have been very slight, and but for the cracked castings have been attended to with the facilities on board. The cost of upkeep is apparently considerably less than for a steam plant of the same power and similar service, and a smaller operating staff is required.

The weight of the installation is about the same as for a triple expansion reciprocating steam plant, but, owing to the fuel economy, about seven per cent. additional cargo carrying capacity is avail-

*"Largest American Marine Diesel Engine Installation Proves Successful," in *Marine Engineering*, June, 1917, p. 244.

able. The performance of the Maumee's engines has demonstrated that large Diesel engines present fewer difficulties in service than do small or medium sized installations, and indicates that Diesel engines of much larger size are entirely feasible.

No oil other than Texaco Ursa Oil has ever been used for the Diesel engines of the Maumee. During the last trip of the Maumee she ran into some very bad weather which lasted nearly forty hours. Sea water broke into the engine room through broken skylights and port-holes and got into the Ursa Oil. This resulted in the oil being whipped up into an emulsion, but the engines operated during the entire period without the slightest trouble, and after the storm was over the emulsion was completely broken up within twenty-four hours. The same oil is still being used at the present writing, and the men on the ship are well pleased with the service of Ursa Oil under such severe conditions.

TEXACO CETUS OIL

THE writer called at a Portland Cement plant today, and upon going to the power house received the following report on our Texaco Cetus Oil which they are using in their turbines. This is certainly a record for turbine oil.

TURBINE AND GENERATOR

Make	Allis-Chalmers
Size	1500 kw.
Speed	1500 r.p.m.
Governor spindle	498 r.p.m.
Oil pump	498 r.p.m.
Cross shaft	310 r.p.m.
Bearing pressure	3.5 lbs.
Relay oil pressure	25 lbs.
Boiler pressure	140 lbs.
Steam inlet	100 lbs.
Vacuum	27.5 lbs.

This machine was installed in January, 1914. The oil reservoir, which is a storage reservoir and not a filter, has a capacity of 100 gallons. Texaco Cetus Oil was placed in the oiling system at the time of installation, since when the turbine has been in operation continuously, except Sundays and twenty-one days that it was shut down for general overhauling. This makes a total of 1,230 days or 29,540 hours of operation. Four times since the turbine was started, that is once each year, the oil has been taken out of the reservoir and poured through a cheese-cloth into a barrel, and replaced in the turbine oil reservoir. This is all the filtering that it has received. Once each month 7.5 gallons of Cetus Oil are added to the reservoir to make up the loss from leakage and evaporation. At no time has there been a dollar spent on this turbine for repairs. The last time it was shut down for general inspection a micrometer was used to measure the bearings, the shafting of the turbine, and the generator, and it was found that it did not show any wear.

In this plant they have two Westinghouse turbine generators of 1000 kw. each. These units receive the same treatment as the one mentioned above, and while they have not been in operation as long, there has never been any trouble due to lubrication. On their dry vacuum pumps the valves are lubricated with Texaco Ursa Oil, and they have never been heard to groan nor have they been found covered with carbon. Texaco lubricants are used throughout this plant.

The engineer of this plant stated that anyone who was having trouble which could be laid to lubrication was at liberty to write to him and he would endeavor to explain the

Texaco way to overcome it. As this gentleman has been erecting engineer for three of the largest turbine manufactories in the United States, as well as having worked in their shops, he has been through the operating game from A to Z with all kinds of turbines and engines, and is therefore in a position to speak authoritatively on the subject.

(Signed) B. C. PHILLIPPO.

TEXACO ALGOL OIL

An Interesting Report from the Foreign Field

November 2, 1917.
Japan Central District.

ISHIGAWA-JIMA SHIPBUILDING YARD,
Tsukishima, Tokyo-Fu, Japan.

During the last two months we have had Texaco Algol Oil tried out at the above shipbuilding yard. The oil was used on two direct-connected enclosed type electric-driven air compressors, running at 380 to 400 r. p. m. and working against a pressure of 120 lbs. per square inch. The diameter of compressor cylinder is 16 inches.

The compressors were built at Ishigawa-jima, and as at least two other shipbuilding yards here have been supplied with the same kind of compressors, we considered it advisable to start with the builders, and after having proved to them the value of Texaco oils, it would be an easy matter to supply the other concerns with an oil which had been found satisfactory by the builders, particularly as the compressor oil which has so far been used for these compressors has always given carbon trouble, and the oil consumption has also been excessive.

These compressors are single-stage and this, in addition to the high pressure and the high speed, creates a condition which can be taken care of successfully by only a few lubricating oils. On August 29th we supplied one barrel of Algol Oil to the above concern for a trial; on September 17th two barrels of the same oil, and on October 26th, three barrels, which proves that the oil was found satisfactory.

The chief engineer was at first a little afraid to use an oil that looked like our Algol Oil. He had been using a Railroad Oil at Yen 1.69 less 10 per cent. per gallon, and we wanted to supply him with Texaco Algol Oil at Yen 1.70 net per gallon. We explained to him that the conditions existing in his compressor cylinders did not call for an oil which was heavily mixed with cylinder stock, also that the reason he had been using such an oil was simply because, until The Texas Company's oils arrived in Japan, he could not obtain an oil with a viscosity heavy enough to meet his requirements, unless he used an oil mixed with cylinder stock. He then agreed to the trial.

The first result of the trial showed that the consumption, which with the oil before in use was 5.8 Go. (one Go. equals .47645 gallons) per twenty-four hours continuous run, with Texaco Algol Oil was found to be only 4.6 Go., or 1.2 Go. less, a reduction of almost 20 per cent. The "repeat" orders then came in, and the chief engineer now reports that he has had no carbon trouble since he started to use Algol Oil. He will use this oil from now on for both of his compressors, and he will also be glad to recommend it to other concerns which are equipped with the same kind of compressors.

(Signed) N. C. BRUUN and T. KAWASAKI.